

Summary of Data on Workplace Exposure to n-Propyl Bromide

The U.S. Environmental Protection Agency's (EPA) Significant New Alternatives Policy (SNAP) Program has received workplace exposure data for n-propyl bromide (nPB) from several different sources. The sources include:

- Data from organic vapor monitoring badges worn by workers using vapor degreasing equipment
- Data from charcoal tube samplers worn by workers using vapor degreasing equipment, cold batch cleaning equipment, aerosols, spray adhesives in foam fabrication, adhesives used for flooring, and manual cleaning
- Area samples taken using both organic vapor monitoring badges and charcoal tube samplers
- Data from three manufacturers or suppliers of products containing nPB
- Data from the National Institute for Occupational Safety and Health from four different facilities
- Data from spray adhesives, a highly emissive use, both before and after improvements to ventilation

The Agency considered these data in determining whether it is feasible to meet the recommended workplace exposure limit for nPB using available, affordable control or ventilation equipment.

Description of exposure data by sector

Non-aerosol solvent cleaning

Almost all samples for solvent cleaning were taken for vapor degreasing.

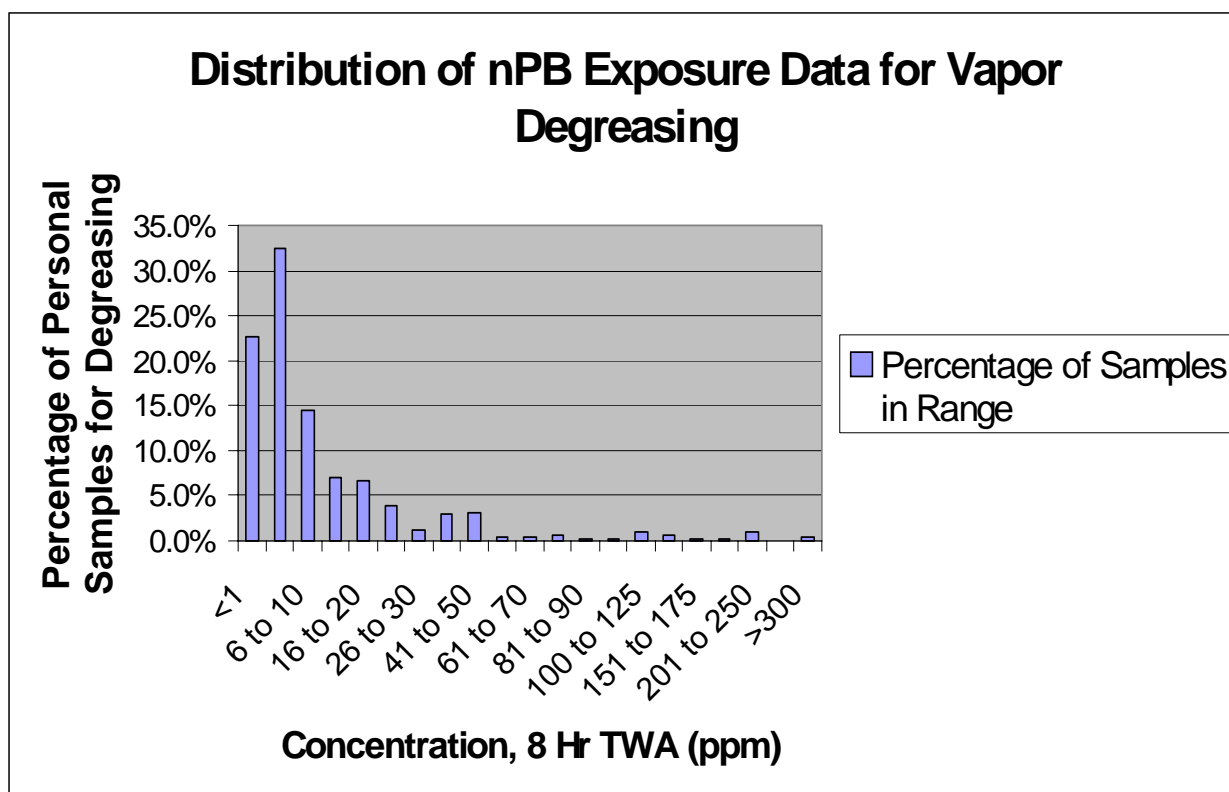
- There are approximately 500 personal samples in all, roughly 90% taken using organic badge monitors (3M or SKC).
- There are approximately 40 area samples, most taken with charcoal tube.
- Data sources for personal samples include exposure data from customers of two suppliers of nPB-based solvents for vapor degreasing, 2003.
- For area samples, EPA also considered data from R.L. Smith, 1998a and 1998b.
- Approximately 75% of the personal samples were below 10 ppm on an 8 hour time-weighted average (TWA)
- >87% of personal samples were below 25 ppm (8 hr TWA)
- In several situations where samples indicated workplace exposure greater than 25 ppm, the supplier and user worked to reduce emissions, and brought them below 25 ppm

Earlier samples taken in 1997 had higher average concentrations than later samples. This may reflect that some manufacturers reduced their recommended workplace exposure limit in 2000, and therefore, users made greater efforts to attain lower emissions.

There also was a Health Hazard Evaluation (HHE) by the National Institute for Occupational Safety and Health (NIOSH) for an air-tight "cold" batch cleaner with ventilation.

Before use of the air-tight cleaning equipment, workers complained of adverse health effects such as headaches, nausea, vomiting, feeling faint, and irritation of the mucous membranes (NIOSH, 2000c). After installing the new equipment, NIOSH measured workplace exposure. NIOSH found that samples taken on 20 employees all read concentrations less than 1 ppm of nPB. These data from NIOSH are not included in the more than 500 personal samples mentioned above, which are all for vapor degreasing.

Figure 1. Distribution of Exposure Data for Vapor Degreasing



EPA also examined data for two other “cold cleaning” applications that are not currently regulated under SNAP: flushing and hand wiping. At one site, personal exposure levels for manual flushing of coils ranged from 5 to 42 ppm, with three samples taken with charcoal tubes. EPA has data for three different sites for hand wiping. The personal samples were all greater than 25 ppm.

Table 1. Exposure Data from Hand Wiping Application

Site	# of Samples	Avg Conc. (ppm)	Conc. Range (ppm)
Hand Wipe Site #1	5	89.3	51.1 to 107.9
Hand Wipe Site #2	2	79.7	67.1 to 92.2
Hand Wipe Site #3	4	Not available	28 to 47 (6 to 10 min. exposure)

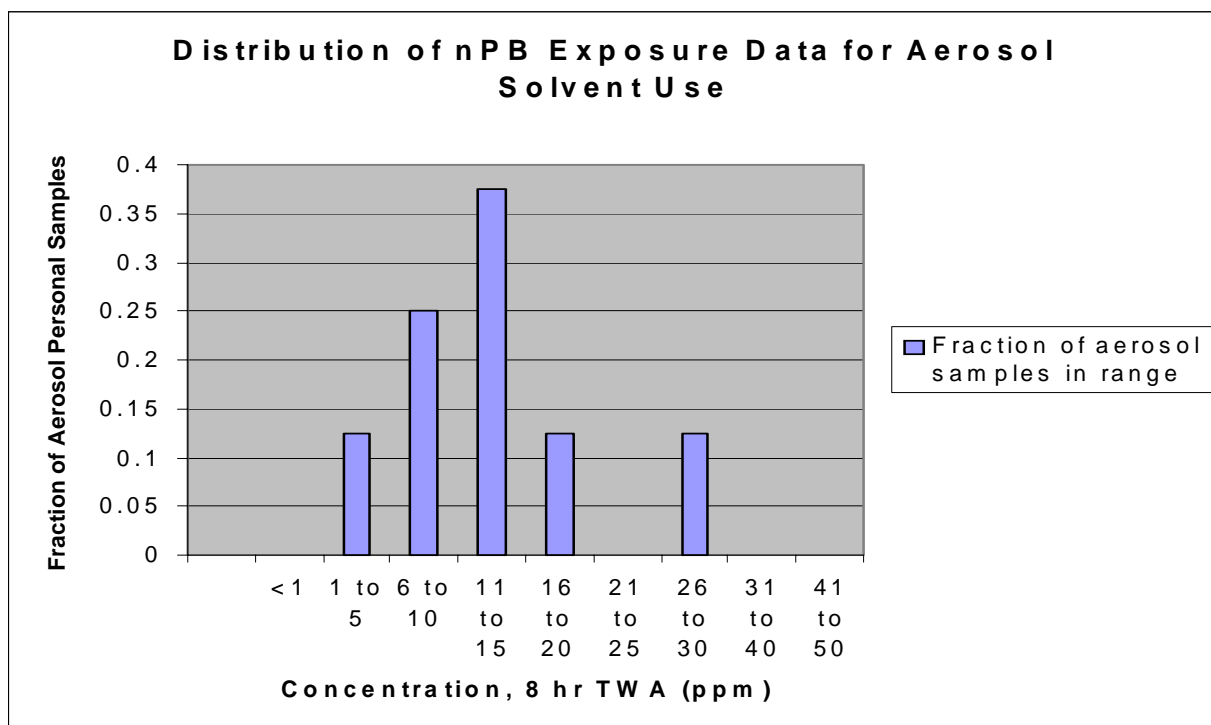
Sources: Smith, R.L. 1998; November 16, 2001 Email from Mick Kassem, Albemarle Corporation.

Aerosol Solvents

Of the three major applications that EPA evaluated, there was the least amount of exposure data for aerosol solvents. There are:

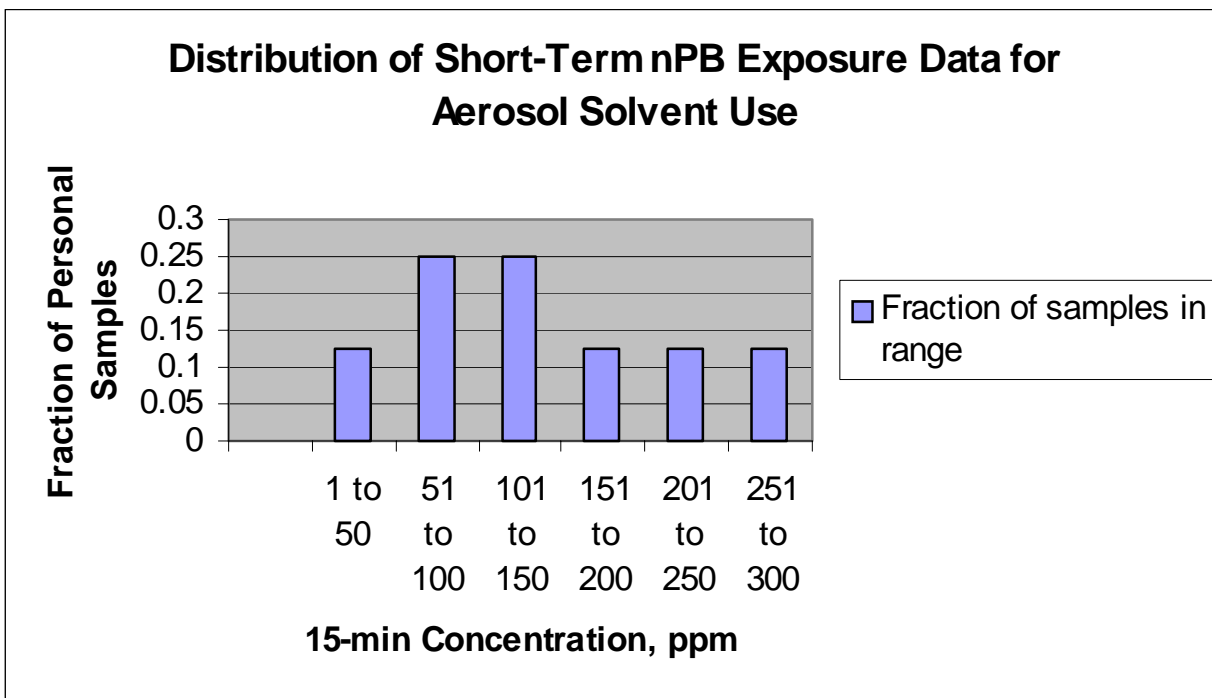
- Eight personal samples on an eight-hour TWA basis, most taken using organic badge monitors
- Four area samples, all taken with charcoal tube samplers
- Eight 15-minute samples, suitable for comparison with a short-term exposure limit (STEL)
- Sources of data include Kassem, 2001 and Aerosol data, 1998.
- The eight personal samples on an eight-hour TWA basis ranged from 5 ppm to 30.2 ppm.
- Seven of the eight personal samples on an eight-hour TWA basis were below 25 ppm.
- The eight 15-minute samples ranged from 45.1 ppm to 254 ppm.

Figure 2. Distribution of nPB Exposure Data for Aerosol Solvent Use (8 hr TWA)



The 15 minute samples are useful for a comparison with a short-term exposure limit (STEL). The samples taken on a eight-hour time-weighted average are useful for comparison with a workplace exposure limit.

**Figure 3. Distribution of Short-Term nPB Exposure Data for Aerosol Solvent Use
(15 Minute Exposures)**



Adhesives

Almost all of the exposure data for adhesives were for spray adhesives using nPB as a carrier solvent in foam fabrication and construction of seat cushions. In addition, there were a few sites where nPB-based adhesives were applied for flooring. There are:

- Approximately 90 personal samples, all taken with charcoal tube samplers
- Five area samples, all taken with charcoal tube samplers
- Data sources include Smith, R.L. 1998, Kassem 2001, NIOSH 2000a, NIOSH 2000b, NIOSH 2001, NIOSH 2002a, and NIOSH 2002b.

There is a marked difference in the exposure data at two sites where NIOSH worked together with the facilities to improve their ventilation.

- Less than half of the personal samples were below 50 ppm on an 8 hour TWA before improving ventilation; 97% of the personal samples were below 50 ppm after improving ventilation.
- The mean concentration before improving ventilation was 141.7 ppm; the mean concentration after improving ventilation was 18.3 ppm.
- After improving ventilation, 78% percent of the samples were at 25 ppm or below.

Figure 4. Distribution of nPB Exposure Data for Adhesives

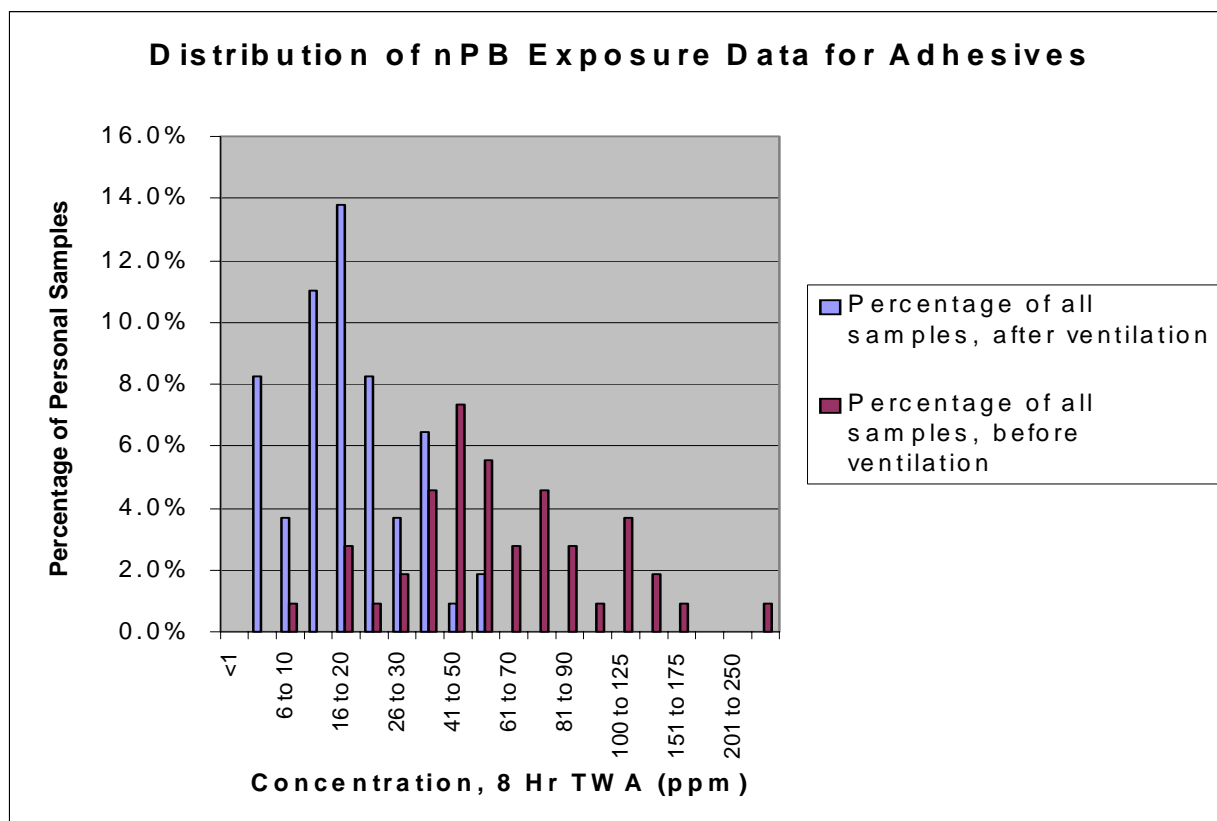


Figure 4 shows the distribution of personal samples taken in adhesives application both before and after making improvements to ventilation. Percentages are a percentage of all personal samples for adhesives for which we have data. Approximately 58% of the person samples are from after ventilation was improved and 42% are from before ventilation was improved. To see percentage of samples within each category, see Figure 5 below.

Figure 4 does not include data from the Letter from Dept. of Health and Human Services (HHS) to Custom Products, Inc., December 1, 1999. The nPB exposure data at this plant were relatively high before NIOSH assisted Custom Products in improving ventilation. However, the individual measurements are not available, and thus they are not included in the distribution above. Table 2 summarizes the data from NIOSH's 1999 letter to Custom Products.

Workplace exposure levels at Custom Products ranged from 60 ppm to 381.2 ppm during NIOSH's initial evaluation. The mean exposure level for the plant was 168.9 ppm. By comparison, after improving ventilation, the mean exposure level dropped almost tenfold to 18.9 ppm, with a range from 1.2 to 58 ppm.

Table 2. Summary of nPB Exposure Data from Adhesives at Custom Products, Prior to Ventilation Improvements

Job Title	Department	# of Samples	Exposure, ppm of nPB (8 Hour TWA)		
			Mean	Minimum	Maximum
	Assembly	36	169.8	60.0	250.7
Sprayers	Assembly	15	193.0	115.3	250.7
Assemblers	Assembly	20	154.7	60.0	234.9
Sprayers	Covers	21	197.0	117.3	381.2
Saw Operator	Saw	12	117.1	85.1	159.2
All Exposure Data		69	168.9	60.0	381.2

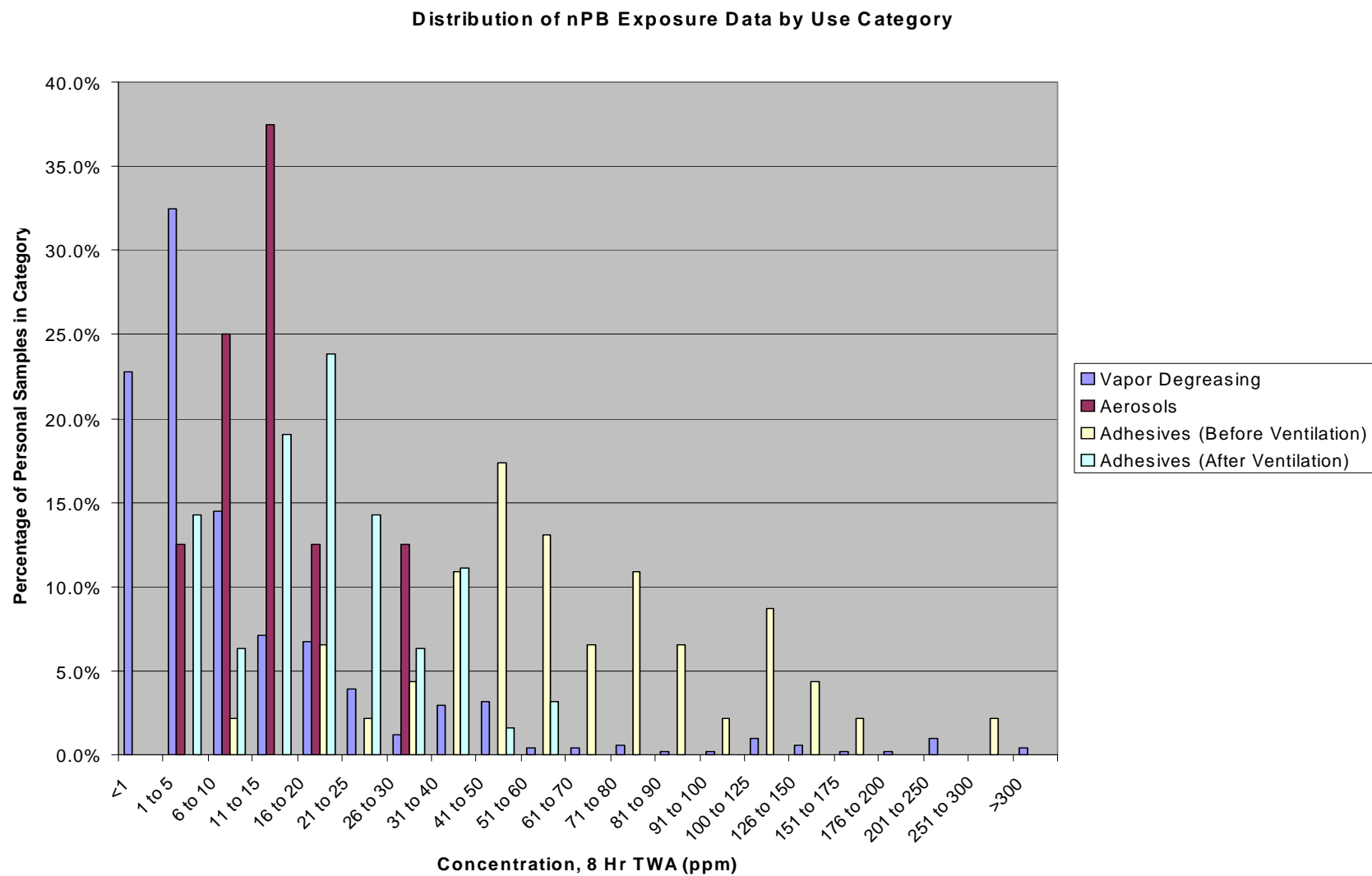
Conclusions

Exposure levels to nPB in the workplace are much lower for vapor degreasing and for air-tight cleaning equipment than for other applications. Most vapor degreasers are capable of containing nPB exposure levels to less than 10 ppm.

There are limited nPB exposure data available for aerosol and cold cleaning applications. These data indicate that aerosol users are likely to attain workplace exposure levels below 20 ppm. On the other hand, hand wiping appears to be a highly emissive application with exposure levels consistently above 25 ppm.

Exposure levels are the highest for adhesives. It is possible to make improvements to ventilation when using adhesives that can reduce exposure levels below 20 ppm on average. Without proper ventilation, nPB exposure from spray adhesives can be extremely high, into the hundreds of parts per million.

Figure 5. Distribution of nPB Exposure Data by Use Category



References

Aerosol data, 1998. Airborne Exposure Assessment of 1-Bromopropane, 1998 (Docket A-2001-07, item II-D-89)

Kassem, 2001. November 16, 2001 Email from Mick Kassem, Albemarle Corporation, concerning exposure levels using nPB in various applications. (Docket A-2001-07, item II-A-19)

NIOSH, 1999. Letter from Dept. of Health and Human Services to Custom Products, Inc., December 1, 1999. Re: results of Dec. 1998 survey of workplace exposure to nPB at Custom Products. (Docket A-2001-07, item II-D-6)

NIOSH, 2000a. Letter from Dept. of Health and Human Services to Marx Industries, Inc., February 1, 2000. Re: results of nPB exposure assessment survey conducted Nov. 16-17, 1999. (Docket A-2001-07, item II-D-7)

NIOSH, 2000b. Letter from Dept. of Health and Human Services to Custom Products, Inc., December 21, 2000. Re: results of nPB exposure assessment survey conducted Nov. 16, 2000. (Docket A-2001-07, item II-D-8)

NIOSH, 2000c. NIOSH Health Hazard Evaluation Report of nPB exposure from cold vapor degreasers at Trilithic, Inc. (HHE Report 2000-0233-2845; Docket A-2001-07, item II-D-11)

NIOSH, 2001. Letter from Dept. of Health and Human Services to STN Cushion Company, March 7, 2001. Re: Results of nPB exposure assessment survey conducted November 14, 2000. (Docket A-2001-07, item II-D-9)

NIOSH, 2002a. NIOSH Health Hazard Evaluation Report: HETA#2000-0410-2891, STN Cushion Company, Thomasville, NC, August 2002 (Docket A-2001-07, item II-A-31)

NIOSH, 2002b. NIOSH Health Hazard Evaluation Report: HETA #98-0153-2883 Custom Products, Inc. November 2002. (Docket A-2001-07, item II-A-49)

Smith, R.L. 1998a. Assessments of occupational exposure to nPB in adhesive spray and metal cleaning applications. Written communications from Robert Smith, Albemarle Corporation to EPA, March 19 through June 26, 1998. (a) 3/19/98; (b) 4/21/98; (c) 4/22/98; (d) 4/23/98; (e) 4/24/98; (f) 5/1/98; (g) 5/29/98; (h) 6/3/98; (i) 6/26/98 (Docket A-91-42, item X-A-57)

Smith, R.L. 1998b. Additional information from Robert Smith (Docket A-91-42, item VI-D-114)

Vapor degreasing data, 2003. Exposure data from customers of two suppliers of nPB-based solvents for vapor degreasing, 2003 (see attached spread sheet and emails)